

Keeping it green: an integrated pest management approach to hemlock woolly adelgid



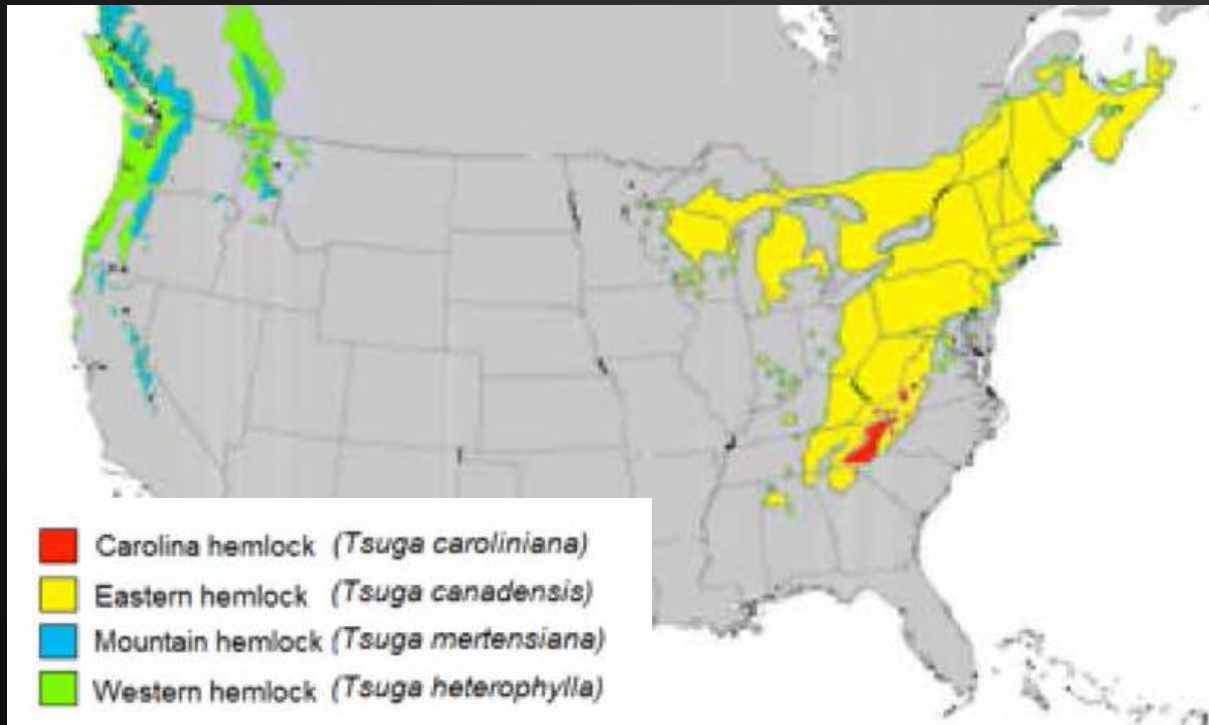
Bud Mayfield
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SRS Science in Practice Webinar Series: 6 October 2021

Eastern and Carolina Hemlock

Tsuga canadensis, *Tsuga caroliniana*

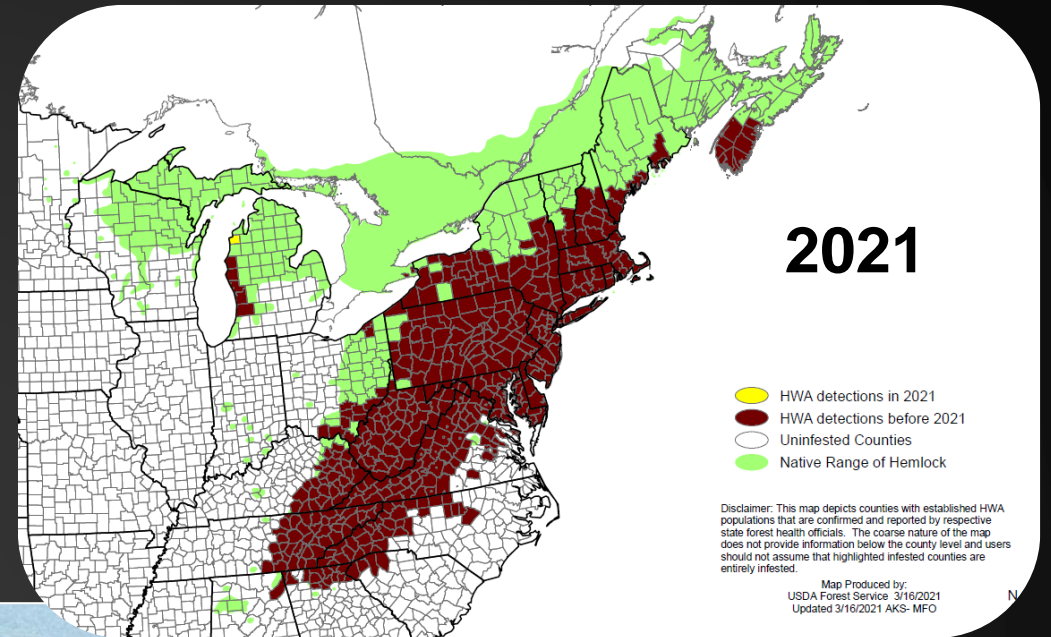
- **Eastern:** Long-lived, shade tolerant, “foundation species”, unique riparian communities
- **Carolina:** Ridges, rocky outcroppings, very narrow distribution in S. Appalachians



Hemlock Woolly Adelgid

Adelges tsugae

- Native to Asia and western North Am.
- Introduced to eastern U.S. from Japan
- Two asexual generations per year
- Mortality and loss of ecological function



Hemlock Woolly Adelgid Toolbox: Integrated Pest Management

**Chemical
Control**



**Biological
Control**



**Genetic
Resource
Conservation**



Silviculture



**Host
Resistance**



Chemical Control

- Effective, short-term protection for individual trees
- Focus: systemic neonicotinoids
 - Imidacloprid (5-7 yrs)
 - Dinotefuran (1-2 yrs)
- Applied tree-by-tree
 - to soil, trunk
- Important to conserving hemlock
- Impractical on forest-wide scale
- Environmental and economic limitations



Figure 6. Common delivery methods of treating hemlock trees with imidacloprid. (a) soil drench; (b) soil injection; (c) tablet formulation, and (d) stem injection. (Credits: a,b. Great Smoky Mountains National Park Resource Management, USDI National Park Service, Bugwood.org; c. Elizabeth McCarty, University of Georgia, Bugwood.org; d. N. Schneeberger, USDA Forest Service)

Biological Control

- *Laricobius nigrinus*
 - Native to PNW, 1st released 2003, widely established
 - Emphasis on field insectaries and redistribution
- *Laricobius osakensis*
 - Native to Japan, 1st released 2012, establishing
- *Laricobius Impact Studies*^{1,2}
 - Substantial predation on HWA winter HWA generation
 - Spring HWA populations rebound rapidly
 - *Need for effective late spring/summer predator*
- Silver flies from PNW (*Leucopis* spp.)
 - *Active research & release; no documented establish. yet*

¹ Jubb et al. 2020 Biol. Con. 143:104180,

² Crandall et al. 2020 Biol. Con. 145:104264



Laricobius nigrinus



Laricobius osakensis



Laricobius Eggs



Laricobius Larva



adult *Leucopis*

B.T. Mudder



Leucopis Larva

NY State Hemlock Initiative

Can Chemical and Biological Control be Integrated?

Integrated
Chem-Bio
Scenario
(hypothetical)

Legend:

•• = HWA

•• = Predator

★ = Insecticide



TIME



Can Chemical and Biological Control be Integrated?

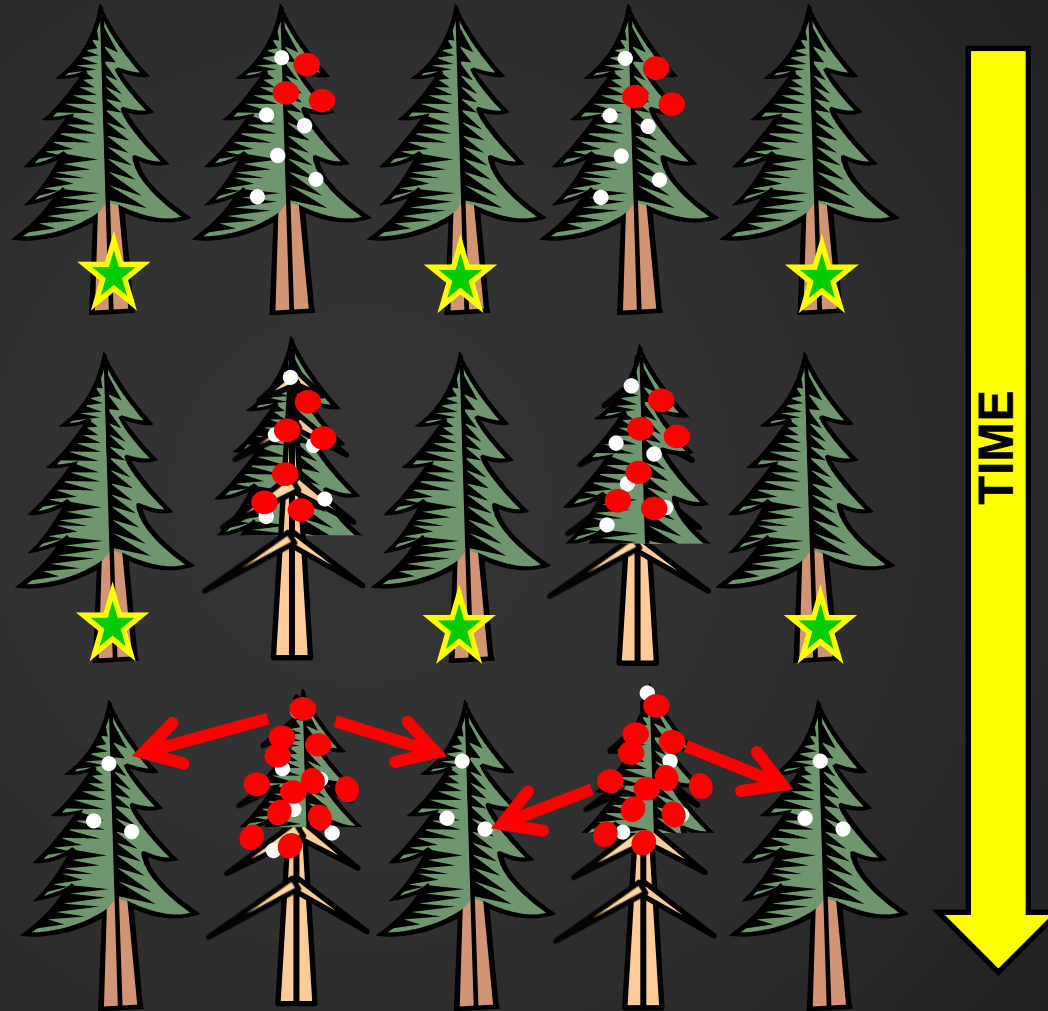
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Publication FHAAS-2018-04

<https://www.srs.fs.usda.gov/pubs/59529>



USDA
United States Department of Agriculture

TECHNOLOGY
TRANSFER

INTEGRATED
PEST MANAGEMENT

INTEGRATING CHEMICAL AND BIOLOGICAL CONTROL OF THE HEMLOCK WOOLLY ADELGID:

A RESOURCE MANAGER'S GUIDE



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FOREST HEALTH ASSESSMENT
AND APPLIED SCIENCES TEAM

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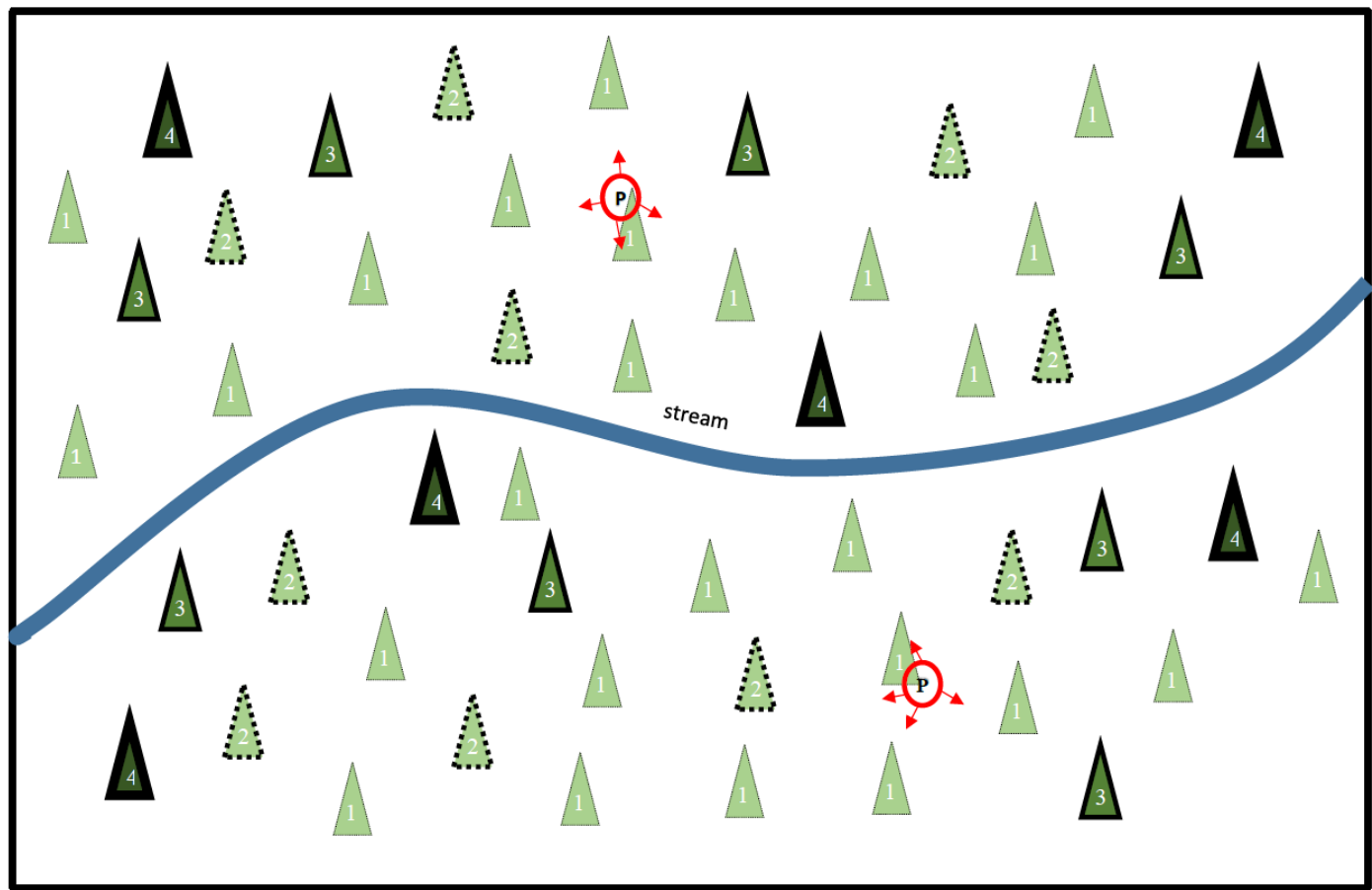
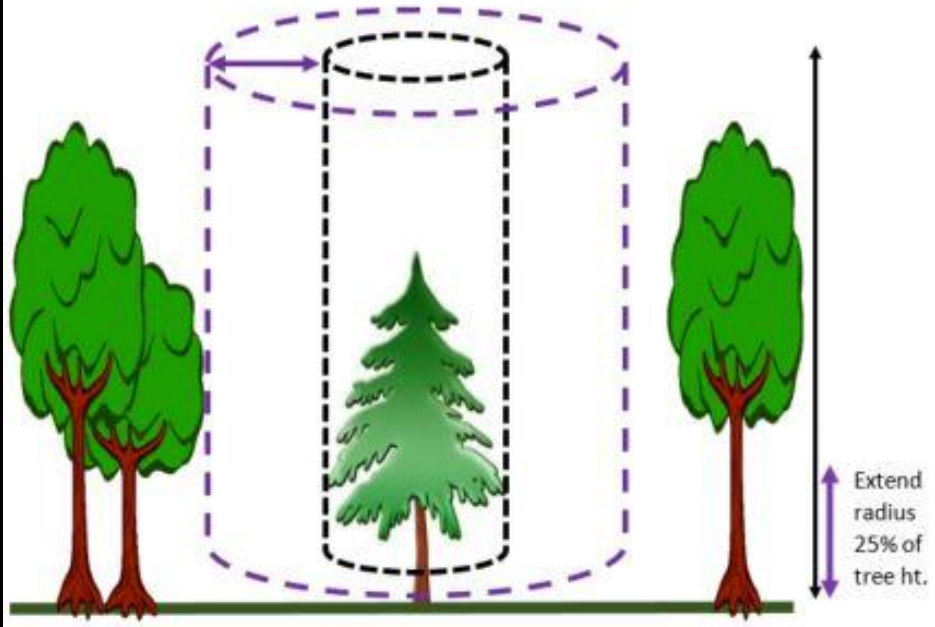
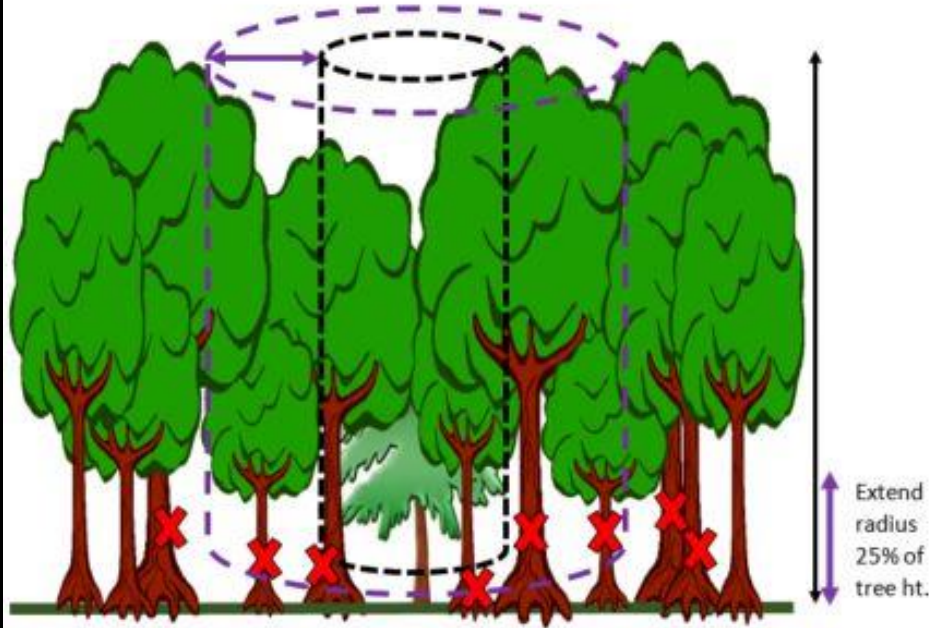


Fig. 3. Large Fell



Silviculture

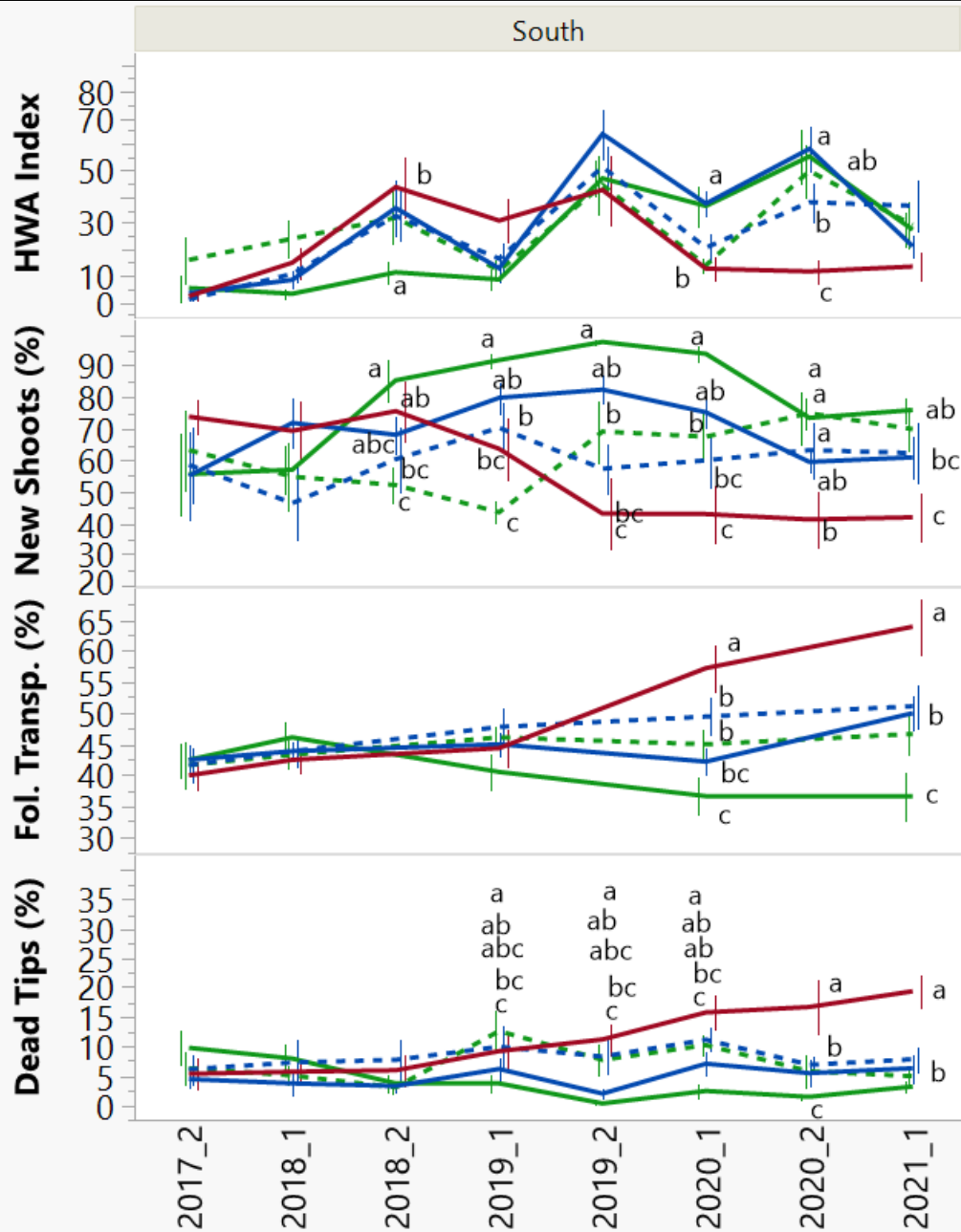


Hemlock Target Tree Release Study

A. Mayfield and R. Jetton (unpublished data)

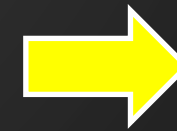
Treatment

- Large Fell
- - Large Girdle
- Small Fell
- - Small Girdle
- Control



Funded through USDA-FS-FHP-STDP

- HWA density variable over time
- Consistently more new shoot growth in “large fell” gap vs. no gap
- Foliage transparency and branch dieback (=poor crown) increased in no gap plots



Putting it Together



Nov 2013



Mar 2017



May 2021

HWA Predator Field Insectary Bent Creek Exp. Forest (NC)

- Silviculture – thinning, planting, competition control
- Chemical – Imidacloprid tablets on most but not all trees
- Biological Control – Release and establishment of predators

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← HEMLOCK



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